TWO METHODS OF THINNING SHORTLEAF PINE IN MISSOURI

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SHORTLEAF PINE

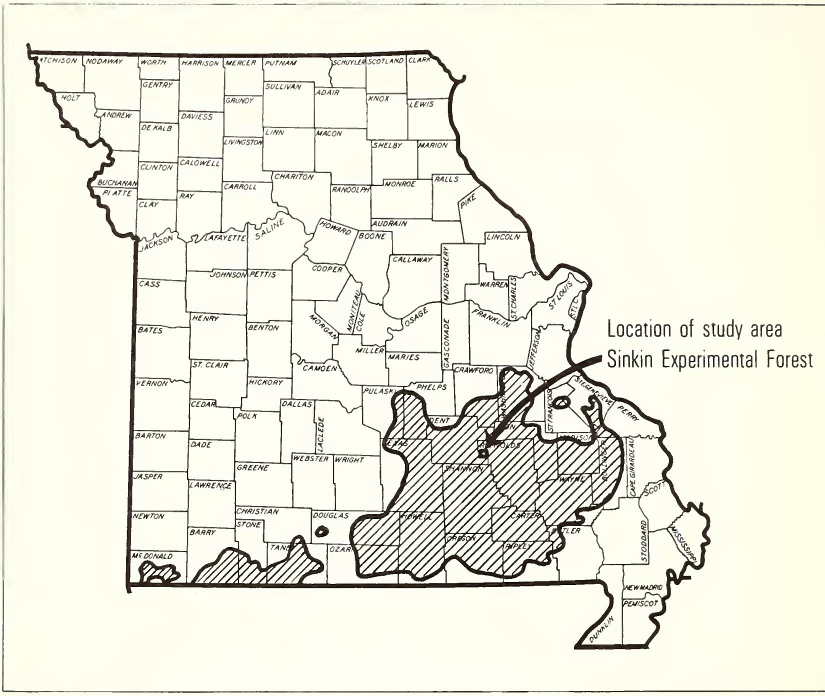
This is the third in a series of three publications on the management of shortleaf pine in the Missouri Ozarks. The other two are: *Stand Density Affects Yield,* and *Understory Hardwoods Retard Growth.*

The natural range of shortleaf pine in Missouri covers about 7 million acres in the east and south-central part of the Ozarks. The forest land here is characterized by rough topography and shallow, rocky, infertile soils. Summer droughts are common in spite of average annual precipitation in excess of 40 inches. As a result, some sites are too poor to produce high-quality hardwood timber. Many of these sites, however, if properly managed, could grow good crops of pine. We have prepared this series of publications to facilitate management of shortleaf pine on such sites in the Missouri Ozarks. The information presented represents the 10-year results of our pine studies.

The authors gratefully recognize the leadership of Dr. Franklin G. Liming in implementing the study upon which this manuscript is based. His efforts in shortleaf pine research in Missouri are now bearing results. Dr. Liming is currently on the staff of the Division of Timber Management Research, U.S. Forest Service, Washington, D.C.

IN MISSOURI

Central States Forest Experiment Station, 111 Old Federal Building
Columbus, Ohio 43215
R. D. Lane, Director



Range of Shortleaf Pine in Missouri

Shortleaf Pine in Missouri

TWO METHODS OF THINNING

Samuel F. Gingrich

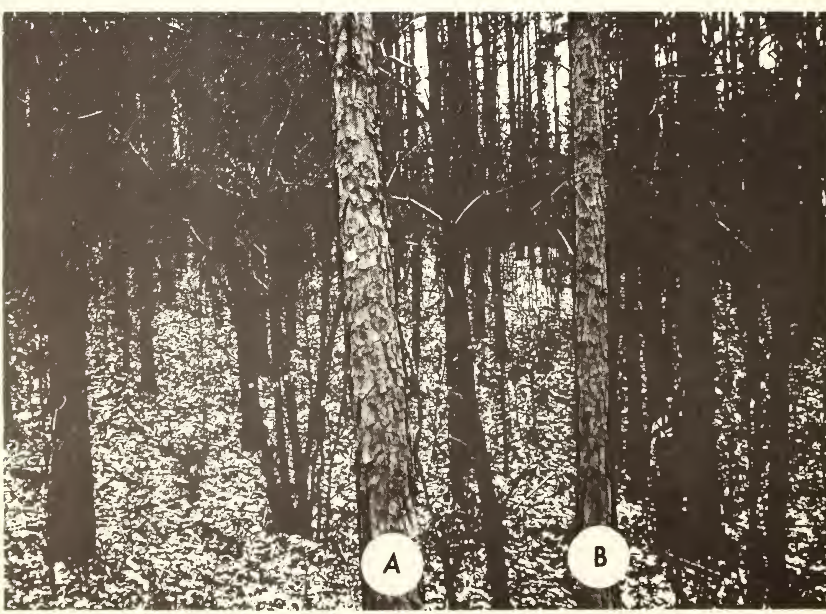
Kenneth A. Brinkman

Nelson F. Rogers

Many young, pure stands of shortleaf pine *(Pinus echinata* Mill.) in Missouri need thinning. "Good" thinning will benefit these stands by increasing individual tree growth, shortening stand rotation, increasing average tree quality, and decreasing mortality. The wrong kind of thinning, however, may do more harm than good. To find out what is "good" thinning for natural stands of pole-size shortleaf pine in the Missouri Ozarks, we compared two methods — thinning from above and from below. Reported here are 10-year results in terms of growth and yield.

Few trees in young, even-aged, natural pine stands have dominant crowns. Certain trees may have larger crowns and correspondingly larger stem diameters, but in general the crown canopy is uniform. Trees of the same age are nearly equal in total height even though stem diameters of the trees in the main stand may range from 4 to 9 inches. In thinning such stands the problem arises which trees to leave (fig. 1). If the small trees are removed, the residual stand will consist of fewer but larger trees than if the larger ones are removed. But removing the small trees may not be commercially feasible. Removing the larger trees will yield higher valued products but may also eliminate genetically superior trees. The only way to resolve the question was to try both methods and see.

FIGURE 1. — The study area in 1951 showing the high density of shortleaf pine before thinning. One of the two trees in the center foreground should be removed because they are too close (less than 2 feet apart) for good growth and development. Both trees have a desirable stem form but the tree on the left (A) is 8 inches in diameter and will yield one pole (class 6 or 7) and two fenceposts, whereas the tree on the right (B) is only 5 inches in diameter and will yield two 7-foot posts.



THE STUDY AREA

The study was conducted in a pine-oak stand on the Sinkin Experimental Forest, Dent County, Missouri. The stand is located on the tops and sides of two main ridges. Slope ranges from 4 to 30 percent. The soil is classified as Clarksville stony loam. Site index is 60 to 65, about average for shortleaf pine in Missouri.

The stand developed naturally after harvest of an oak-pine stand about 1918. Since 1933 this area has been a part of the Clark National Forest and has not been burned. Most hardwood trees in the stand were cut or girdled in 1934 and the pines were thinned from about 1,100 to 600 trees per acre.

This early thinning eliminated the poorest pine trees, removed most competing hardwoods, and left the better pine trees free to grow. By 1951, however, the need for another thinning was indicated by reduced diameter growth, complete crown closure, and the presence of many overtopped trees.

Pine trees ranged in diameter from 1 to 12 inches, averaging 6.4 inches. Dominant and codominant trees were about 50 feet tall. Pine basal area averaged 138 square feet per acre.

Most hardwoods had resprouted by 1951 — when the stand was about 30 years old. The stands contained about 900 hardwoods per acre 0.6 inch d.b.h. and larger with a basal area of 14 square feet. In addition, there were about 3,500 smaller hardwood stems per acre. The most numerous understory species were black oak *(Quercus velutina* Lam.), white oak *(Q. alba* L.), sassafras *(Sassafras albidum* (Nutt.) Nees), and dogwood *(Cornus* L. spp.).

Thinning Methods

Each thinning method (thinning from above and thinning from below) was replicated three times on ½-acre plots. In selecting pine trees to leave, primary consideration was given to tree size. In thinning from above the smallest trees were left; in thinning from below the largest trees were left. Both thinnings left the best possible trees, those with single, straight, well-formed boles that were free of large knots and other surface defects. These procedures were modified only when they would have resulted in poor spacing of leave trees. All stands were thinned to 70 square feet of basal area. All plots had some hardwoods present, mostly oak saplings in the understory. The larger hardwoods were cut and the foliage of small trees and sprouts was sprayed with 2,4,5-T to remove any confounding effects of thinning method and hardwood competi-

tion. Additional foliage spray was applied in 1955 and 1959 to further control understory hardwoods.

In 1961, ten growing seasons after the first thinning, the plots were again thinned to 70 square feet of basal area. The same methods of thinning were used.

Residual Stand Conditions After the First Thinning

Thinning from above yielded the most volume (table 1) and left about 120 more trees per acre than thinning from below (fig. 2). In the stands thinned from above the average tree diameter was reduced by more than ½ inch whereas thinning from below increased the average tree diameter by more than 1 inch.

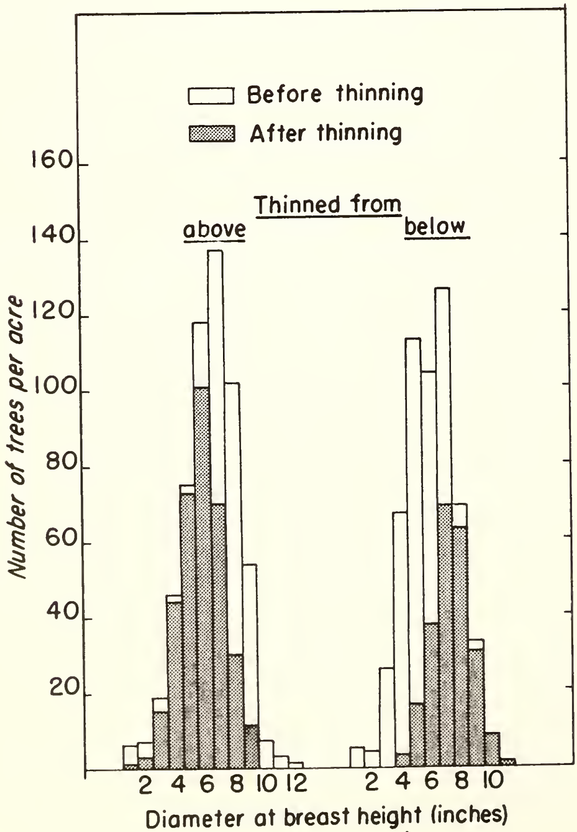


FIGURE 2.— Distribution of pine trees as affected by thinning method.

Table 1.--Pine stand conditions before and after the 1951 thinning

(Per acre)

Thinned from--	Basal area in square feet		Number of trees		Cubic-foot volume: 5 inches d.b.h. and larger[1]		Board-foot volume: 7 inches d.b.h. and larger[2]	
	Before	After	Before	After	Before	After	Before	After
Above	142	70	575	348	2,265	1,020	6,450	1,980
Below	122	70	556	227	1,855	1,220	4,700	3,870

1/ To a 3-inch top (d.i.b.).
2/ To a 5-inch top (d.i.b.) (International 1/4-inch rule).

10-YEAR RESULTS

During the 10 years of the study so far, stands thinned from below grew at about the same rate and showed similar responses to treatment. Although stands thinned from above grew at least as well as the others, a realistic evaluation of the long-range effects of thinning methods cannot be made on the basis of growth during this first 10-year period.

Basal-area growth was similar in all stands regardless of thinning method (table 2). Although total stand basal area increased somewhat more in stands thinned from above, this growth was divided among the more numerous small trees.

Mortality due to ice storms was higher in the stands thinned from above, partially because of the root and crown characteristics of the residual trees. The 1961 thinning maintained the earlier differences in number of trees between treatments.

Thinning from above in 1961 eliminated most of the trees larger than 8 inches and reduced average stand diameter from 7.4 inches to 6.8 inches. In contrast, this second cutting increased average diameter in the stands thinned from below from 9.2 inches to 9.8 inches. This difference of 3 inches in average tree diameter will increase saw-log rotation in the stand thinned from above by about 20 years at current growth rates (fig. 3) even though thinning is done from below from now on.

Table 2.--Effect of method of thinning on total growth and yield (including mortality) from 1951 to 1961 (all hardwoods were eliminated)

(Per acre)

	Thinned from--	
	Above	Below
Basal area (square feet)		
Yield 1951	71.9	51.9
Left 1951	70.2	70.1
Growth 10 years1/	40.7	38.4
Yield 10 years1/	41.7	38.3
Left 1961	69.2	70.2
Total production2/	182.8	160.4
Volume (cubic feet)3/		
Yield 1951	1,245	635
Left 1951	1,020	1,220
Growth 10 years1/	1,080	900
Yield 10 years1/	825	720
Left 1961	1,275	1,400
Total production2/	3,345	2,755
Volume (board feet)4/		
Yield 1951	4,470	830
Left 1951	1,980	3,870
Growth 10 years1/	5,860	5,440
Ingrowth	1,315	460
Yield 10 years1/	3,615	2,870
Left 1961	4,225	6,440
Total production2/	12,310	10,140
Number of trees		
Total trees	575	556
Cut 1951	227	329
Left 1951	348	227
Mortality	25	6
Cut 1961	77	91
Left 1961	246	130

1/ Includes mortality.
2/ Sum of the 1951 and 1961 yields plus the stand left in 1961.
3/ Gross peeled volume in cubic feet to a 3-inch top (d.i.b.).
4/ Gross volume to a 5-inch top (d.i.b.) (International 1/4-inch rule).

During the 10-year period, the cubic-foot-volume increase in the stands thinned from above was about 10 percent more than in the other stands (table 2). Ingrowth in stands thinned from above was more than 1,300 board feet, however, compared with 460 board feet in the other treatment.

FIGURE 3. — The difference in tree size of residual stands is obvious after two thinnings: This stand was thinned from above with an average tree size of 6.8 inches;

This one was thinned from below with an average diameter of 9.8 inches.

It is apparent that the release afforded the small trees by thinning from above still was effective when the trees were 40 years old. Although many trees had short, narrow crowns, these developed rapidly after release, and both height and diameter growth rates increased.

Yield and Quality

In 1951, the products cut from the stands thinned from above were worth $73 per acre as stumpage, compared with $24 per acre for yields from the stands thinned from below (table 3). Reasons for this difference are obvious: original board-foot volume was greater in the stands thinned from above and the largest trees were cut. In 1961, however, the products cut were worth about the same in all stands.

Table 3.--Yields per acre from the 1951[1] and 1961[2] thinnings

Yields	Thinned from-- Above 1951	Above 1961	Below 1951	Below 1961
Trees cut (5 inches d.b.h. and larger)				
Number	211	75	231	91
Average diameter (inches)	7.8	9.3	5.9	8.4
Posts				
Number	175	112	362	197
Average length (feet)	7.0	8.8	7.0	8.5
Poles				
Number	112	93	71	94
Average length (feet)	22.1	20.8	20.1	19.9
Saw logs				
Number	188	15	53	9
Volume (board feet)[3]	1,420	329	446	173
Value (dollars)[4]				
Each thinning	73	97	24	88
Total	170		112	

1/ Potential yield assuming a graded-pole market. All trees were actually sold as posts or saw logs but each saw-log tree was first scaled in terms of graded poles.

2/ Product yield, representing the actual 10-year growth.

3/ International 1/4-inch log rule.

4/ Actual stumpage value received from local commercial operator at the time of thinnings. Product prices represent the actual market conditions at that time of thinning and do not necessarily represent present conditions.

Nearly two-thirds of the income from all thinning treatments in 1961 was from the sale of poles. Because the largest trees were cut in the stands thinned from above, both saw-log volume and the value of individual trees harvested were greater here than in the other stands where most such trees were left (table 3). In future thinnings, however, income will probably be greater in the thinning from below because the trees removed will be larger than the trees removed in the stands thinned from above. Even after two thinnings the increase in the grade of poles removed in the stands thinned from below was much greater than the grade increase in the other stands. Actually there were very minor differences in the grade or quality of poles removed in the second thinning.

RECOMMENDATIONS

The small investment in growing stock during this 10-year period in relation to growth and yield makes thinning from above seem attractive. But the decreasing response to release with age, the longer saw-log rotation, and the possibility of perpetuating genetically inferior trees cannot be ignored.

Thinning from above may be good short-term economics and poor long-term management. If practiced at all, it should be limited to one thinning early in the rotation. This would permit the recovery of a high proportion of the investment in growing stock. Succeeding thinnings should be made from below.

THE AUTHORS

SAMUEL F. GINGRICH began his Forest Service career in 1957 after 6 years as an instructor of forest mensuration and management at The Pennsylvania State University. Gingrich received his B.S. degree from Penn State in 1950 and his M.S. degree in 1954. He served 3 years in the Navy Air Corps during World War II. Sam is a member of Xi Sigma Pi and Gamma Sigma Delta, honor societies of forestry and agriculture, and the Society of American Foresters. He is Project Leader for the Station's research in forest mensuration.

KENNETH A. BRINKMAN began his Forest Service career at the Central States Station in 1938. He soon moved to Mississippi with the Southern Forest Experiment Station, then to Arizona with the Southwestern Station, then to Alabama with the Southern Station again. Finally, in 1948, he returned to the Central States and worked in Iowa until 1955. Since then he has been at our Columbia, Missouri, field office. A lieutenant in the Coast Guard during World War II, Brinkman was commanding officer of a subchaser and later a tanker. Ken got his forestry training in his native state of Iowa, earning B.S. and M.S. degrees at Iowa State University. He is a silviculturist specializing in regeneration, woody-plant control, and conversion of low-quality oak stands.

NELSON F. ROGERS has been with the U.S. Forest Service for more than 30 years — 20 of them with the Central States Forest Experiment Station. Before beginning his research career he served on National Forests throughout eastern United States. Nelson is a graduate of the State University of New York College of Forestry. Although Rogers' primary responsibility is serving as Superintendent of the Station's Sinkin Experimental Forest near Salem, Missouri, his active participation in silvicultural research projects has resulted in more than a dozen publications.

The Forest Service of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.